BAD KREUZNACH MILITARY COMMUNITY

ENERGY ENGINEERING ANALYSIS PROGRAM

EXECUTIVE SUMMARY

KLING LINDQUIST, INC.
PHILADELPHIA, PENNSYLVANIA

ROBERT M. HOUSTON, GmbH
FRANKFURT/MAIN, GERMANY

PHASE III SUBMISSION

APRIL 1984

DEPARTMENT OF THE ARMY
CONSTRUCTION ENGINEERING RESEARCH LABORATORIES, CORPS OF ENGINEERS
P.O. BOX 9005
CHAMPAIGN, ILLINOIS 61826-9005

REPLY TO
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Marie Wakefield,
Librarian Engineering

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EXECUTIVE SUMMARY

FOR THE

ENERGY ENGINEERING ANALYSIS PROGRAM (EEAP)

OF

BAD KREUZNACH MILITARY COMMUNITY

UNITED STATES ARMY

PREPARED FOR

DEPARTMENT OF THE ARMY
EUROPE DIVISION, CORPS OF ENGINEERS
Contract No. DACA-90-82-C-0187

PREPARED BY

KLING-LINDQUIST, INC., ENGINEERS
2301 CHESTNUT STREET
PHILADELPHIA, PENNSYLVANIA 19103
K/L No. 82-1889-00

ROBERT M. HOUSTON, GmbH
FRANKFURT/MAIN GERMANY

APRIL 1984
REVISED OCTOBER 1984

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EXECUTIVE SUMMARY

1.0 INTRODUCTION

1.1 General

This summarizes the results of an Energy Engineering Analysis Program (EEAP) of the Bad Kreuznach Military Community. It was conducted by Kling-Lindquist Engineers, Inc. (K/L) for the Department of the Army, Europe Division of the Corps of Engineers under Contract No. DACA-90-82-C-0187. Kling-Lindquist, Inc., employed the services of Robert M. Houston GmbH (RMH), Frankfurt, Germany, to assist in the field survey, cost estimating and other phases of the work requiring local knowledge.

1.2 Project Objective

The objective of this project was to identify cost effective means by which energy consumption at the Military Community can be reduced in accordance with the goals and objectives set forth in the Army Facilities Energy Plan (AFEP). This plan has set a goal for FY 85 to reduce energy consumption by 20% from the total energy consumption of FY 75.

1.3 Scope of Services Summary - Increments of Work

The Scope of Services for this EEAP required that analyses and investigations be performed on the facilities' energy consuming systems in the Bad Kreuznach Military Community. These investigations and analyses are catagorized into Increments of Work based on the types of energy consuming systems. The Increments of Work included in this contract are as follows:

- Increment "A" - Energy Conservation Investigations, Analyses and Recommendations for Facilities and Processes.
- Increment "B" - Energy Conservation Investigations of Utilities and Energy Distribution Systems, Energy Monitoring and Control Systems (EMCS), Existing Energy Plants
- Increment "F" - Facility Engineer Energy Conservation Measures
- Increment "G" - Projects which do not qualify for ECIP Funding in other increments of work but are viable energy saving projects

1.4 MILCOM Installations Included in EEAP

This EEAP was performed for energy consuming facilities in GY Area installations in the Bad Kreuznach Military Community as follows:

GY NUMBER	CODE	GY NAME
026	BKAF	Bad Kreuznach Airfield
057	AB	Anderson Barracks
095	MSP	Moersfeld Storage Point
113	FCP	Fuerfeld Class III & V Point
160	BKFH	Bad Kreuznach Family Housing
246	MK	Minick Kaserne
335	BKH	Bad Kreuznach Hospital
478	SSF	Spabruecken Storage Facility
510	GCMK	G.C. Marshall Kaserne
562	RB	Rose Barracks
615	RTSA	Rheingrafenstein Training & Storage Area
727	DFH	Dexheim Family Housing
954	WTOF	Wueschheim Tactical Operation Facility
986	BKC	Bad Kreuznach Community
*737	DMS	Dexheim Missile Station
*789	COTA	Camp Oppenheim Training Area
**790	WMS	Wueschheim Missile Station
*791	DMS	Dichtelbach Missile Station

* No energy use
** Deactivated

1.5 Project Execution

The engineering services for this project were accomplished in three phases as follows:

- Phase I - Data Gathering and Facilities Survey. Personnel of Kling-Lindquist Engineers, Inc., Philadelphia, Penna., and Robert M. Houston, GmbH Frankfurt, Germany, conducted surveys of existing facilities and heating plants with respect to their use, construction and energy consuming systems. Data was also obtained from available Community records which included past energy consumption and cost reports, facility lists, and energy conservation projects completed and planned (funded) by the Community. A "kick-off" meeting was held with the Community prior to the start of the survey and an "exit interview" was conducted at the completion of the survey. The data collected was compiled and submitted to the Corps

of Engineers and the Community at the end of Phase I. A follow-up presentation took place at the Community to highlight the information gathered and to preview the project tasks and work plan for for the subsequent phases of work.

- Phase II - This phase consisted of analysis of data, computer modeling of selected facilities listed in Annex "B" of the Statement of Services (SOS), verification of energy calculations against historical records for each GY area, identification of energy conservation opportunities (ECO) with high Savings to Investment Ratios (SIR), feasibility and economic evaluation of selected ECO's and the preparation of the front pages of the DD Form 1391. Preparation of the Energy Report presenting the analysis results and recommendations for the entire Community wide study was submitted at the conclusion of Phase II.

  A follow up presentation was made to the Community to highlight the results of the Phase II work. Topics covered included calculation methodology, discussion of the existing energy situation, Energy Conservation Opportunities (ECOs) analyzed, proposed grouping of the ECOs into projects, and impact of the ECOs being proposed on the energy consumption for the Communities.

  A meeting with the Community took place after the presentation to receive Community direction regarding packaging of the ECOs into projects.

- Phase III - Preparation of project documents which include DA-Form 4283:S and/or completed DD Form 1391 including Project Development Brochures Part 1 (PDB-I), and submittal of the Executive Summary for the project in accordance with the Scope of Services outline.

1.6 Energy Units

The Community consumes energy in various forms. Standard Energy Conservation Investment Program (ECIP)approved conversion factors were used to convert the different energy source values into common units as follows:

Electricity	-	11,600 BTU/Kilowatt Hour
Distillate Fuel Oil (No. 2)	-	138,700 BTU/Gallon (US)
Residual Fuel Oil (No. 6)	-	145,000 BTU/Gallon (US)
Coal	-	27,990,000 BTU/Metric Ton (2,200 lbs.)

2.0 EXISTING ENERGY SITUATION

2.1 Baseline Energy Consumption (FY 75)

Energy consumed by the Community in FY 75 represents the "Baseline Consumption". The Army Facilities Energy Plan (AFEP) has set a goal to reduce, by FY 85, energy consumption 20% below the "Baseline Consumption".

FY 75 energy consumption was derived from recorded data obtained from the Bad Kreuznach Military Community and is as follows:

ENERGY SOURCE	CONSUMPTION MILLION BTU	PERCENT OF TOTAL	COST DOLLARS	PERCENT OF TOTAL
Electricity	242,033	33	$ 938,921	40
Distillate Fuel Oil (No.2)	421,446	57	1,238,814	53
Residual Fuel Oil (No.6)	39,954	5	88,549	4
Coal	32,871	5	63,017	3
Total	736,304	100	$2,329,301	100

2.2 Source Energy Consumption (FY 82)

Energy consumed by the Community in FY 82 represents the "Source Consumption" for this EEAP Study. Energy records for FY 82 were the most recent and complete fiscal year data available for the EEAP. This consumption was designated as the "Source Consumption" since it serves as the reference point for evaluating current compliance with the Army Facilities Energy Plan and also to verify the accuracy of the energy model to be developed for the Community. This energy model will then be used in evaluating Energy Conservation Opportunities.

The energy consumption data for FY 1982 was derived from recorded data obtained from the Bad Kreuznach Military Community and is as follows:

ENERGY SOURCE	CONSUMPTION MILLION BTU	PERCENT OF TOTAL	COST DOLLARS	PERCENT OF TOTAL
Electricity	265,891	40	$1,604,537	33
Distillate Fuel Oil (No.2)	326,719	49	2,850,253	58
Residual Fuel Oil (No.6)	44,952	7	271,706	6
Coal	26,408	4	150,250	3
Total	663,970	100	$4,876,746	100

2.3 Present Compliance with AFEP

A comparison of the FY 1975 to FY 1982 consumption records indicates that FY 82 energy consumption by the Community had changed from FY 75 as follows:

ENERGY SOURCE	PERCENT CHANGE
Electricity	+ 10
Distillate Fuel Oil (No.2)	- 22
Residual Fuel Oil (No.6)	+ 13
Coal	- 20
Change	- 10% (Decrease)

2.4 Review of Past Consumption

Energy consumption obtained from Community records is summarized by GY area for FY 75 and FY 82 as follows:

GY	GY	FY 75 CONSUMPTION			FY 82 CONSUMPTION		
		MILLION		BTU	MILLION		BTU
NO.	NAME	BTU	%	PER SF**	BTU	%	PER SF***
026	BKAF	5,239	0.7	368,554	6,844	1.0	481,534
095	MSP	2,816	0.4	322,677	1,983	0.3	226,997
113	FCP	0	0	-	318	0.05	2,628,099
160	BKFH	216,748	29.4	143,431	188,032	28.3	124,429
246	MK	24,752	3.4	185,146	25,953	3.9	194,127
335	BKH	81,005	11.0	177,845	58,761	8.8	129,011
478	SSF	0	0	-	511	0.05	2,823,204
510	GCMK	60,741	8.2	101,387	69,257	10.4	337,794
562	RB	139,035	19.0	206,066	149,001	22.4	220,836
615	RTSA	3,201	0.4	200,954	4,581	0.7	287,651
727*	DFH	122,857	16.6	235,607	115,708	17.5	238,507
954	WTOF	12,503	1.7	1,026,266	3,750	0.6	307,831
986	BKC	1,438	0.2	67,718	1,806	0.3	85,048
790	WMS	26,439	3.6	551,767	10,383	1.6	216,687
791	DMS	39,530	5.4	673,585	27,082	4.1	461,473
		736,304	100	199,735 (Avg.)	663,970	100	182,189 (Avg.)

* GY 057 and 737 included with 727
** Based on total MILCOM Facility Area of 3,686,410 (FY 75)
*** Based on total MILCOM Facility Area of 3,644,398 (FY 82)

Several comments can be made with respect to this data.

- In terms of total energy the three largest energy users are GY Areas 160, 562, and 727/057 which contain barracks and family housing.

- In terms of total energy per square foot, the largest users are GY Areas which have a small facility area. Included are GY 026, 095, 113, 478, 954, and 791. In addition, several of these also have increased power requirements for mission related special systems.

This same information is presented graphically in Appendix Figures A-1 and A-2. In addition, the consumption by energy type is also presented graphically in Figures A-3 (coal), A-4 (fuel oil) and A-5 (electricity). Comments relating to those Figures are as follows:

- Coal - There was a large decrease in the use of coal at GY 057/727/737. This resulted from the removal of individual coal-fired boilers as buildings were tied on to a new central plant with oil-fired boilers.

- Fuel Oil - Consumption has reduced at almost all GY Areas. This has resulted from boiler plant consolidation projects and installation of new, more efficient boilers. In addition, the Community has implemented energy conservation measures such as weather responsive controls, thermostatic radiator valves, and new thermal windows which have caused a reduction in consumption.

- Electricity - Consumption has increased in almost all GY Areas. This is believed to be the result of increased use of electrical appliances (stereos, televisions, etc.) in living quarters (barracks and family housing) and office area computerization (i.e., micro computers, word processors, copiers, etc.). In addition, large reductions took place at certain GY Areas (954/790/791) as a result of their deactivation.

3.0 ENERGY MODEL

3.1 Computer Modeled Facilities

Certain facilities in the Community were designated in the Scope of Services for computer modeling on the basis of their being representative "typical" samples of other similar types of facilities in the Community.

Computer analyses of each model were performed to determine peak loads and annual energy requirements to meet facility energy needs for heat, domestic hot water, lighting, receptacle power, equipment power and special process systems. These energy requirements then served as a data base which could be factored to arrive at energy requirements for all similar facilities not modeled. A summary of the energy requirements for the "typical" facilities, which were computer modeled, is presented in Appendix Table A-1.

3.2 Heating Plant Efficiencies

Energy for facility heat and domestic hot water requirements is, for the most part supplied by heating plants. The heating plants have been categorized by size as follows: single building heating plants; multiple building heating plants, which serve less than five buildings or have less than 10 million Btu installed capacity; central heating plants which serve five or more buildings or exceed a 10 million Btu installed capacity; and lastly electric heating. A summary of the heating plants in the Community is as follows:

PLANT TYPE	AREA SERVED TOTAL SQ.FT.	AREA SERVED (%)OF TOTAL	INSTALLED CAPACITY MILLION BTU	INSTALLED CAPACITY (%)OF TOTAL	AVG. OUTPUT BTU/SQ.FT.
SINGLE	1,774,826	51	130,817	46	73,700
MULTIPLE	434,090	13	35,495	12	81,800
CENTRAL	1,230,600	36	111,728	39	90,800
ELECTRIC	15,065	--	6,278	3	416,700
TOTAL	3,454,581	100	284,318	100	82,300 (Avg.)

Heating plant efficiencies were determined for each heating plant. The efficiency relates fuel energy input to energy output delivered to the facilities. The difference between the two is energy output loss at the boiler which results from combustion, radiation, unburned fuel (coal), blowdown and losses in the system resulting from distribution, flashing (steam systems), and leakage.

3.3 Generic Facilities

Energy consuming facilities in the Community not computer modeled were designated as "generic" facilities since each was generically classified to a computer modeled facility based on its similarity to the model. Energy requirements for each generic facility were derived from the energy requirements of the modeled facility considered similar.

3.4 Community Energy Model

An energy model for the Community was developed using a computerized data base system. Input data to the model included the following: primary categories of energy requirements calculated for each computer model facility, physical characteristics (length, width, height, percent of glass, etc.) of each energy consuming facility (both models and generics) and heating plant capacities and efficiencies. Procedures were developed for the energy model which adjust the model facility energy requirements to a generic facility based on dimensional or area differences between the model facility and the generic facility to arrive at energy requirements for the generic facility.

Energy requirements are summarized by heating plant and after application of heating plant efficiency data the fuel energy input was determined for each plant.

3.5 Calculated Energy Consumption

The fuel energy consumption for each heating plant was totaled and the resultant calculated Community Energy Consumption determined. Table 1 presents the results of the calculated energy consumption for each GY Area in the Community and compares it to the "Source Consumption" recorded in FY 82.

RECORDED OR "SOURCE CONSUMPTION"

Electricity	-	14,656,339*	kWh	or	170,014 x 10^6 BTU
Distillate Fuel Oil (No. 2)	-	2,332,235**	Gal.	or	323,481 x 10^6 BTU
Residual Fuel Oil (No. 6)	-	301,896	Gal.	or	43,775 x 10^6 BTU
Coal	-	1,105	MT	or	30,929 x 10^6 BTU
					568,199 x 10^6 BTU

"CALCULATED CONSUMPTION"

Electricity	-	14,782,840*	kWh	or	171,481 x 10^6 BTU
Distillate Fuel Oil (No. 2)	-	2,112,679***	Gal.	or	193,029 x 10^6 BTU
Residual Fuel Oil (No. 6)	-	287,716	Gal.	or	293,029 x 10^6 BTU
Coal	-	942	MT	or	26,367 x 10^6 BTU
					532,306 x 10^6 BTU

DIFFERENCE = (532,306 - 568,199)/568,199 = -.063 OR -6.3%

*Electrical consumption for GY 057,727,737 not included.
**No. 2 Oil consumption of GY 737 not included.
***No. 2 Oil consumption for GY 615 not included.

The calculated consumption was found to be 6.3% less than the FY 82 "Source Consumption", which was within the 10% limit required by the Scope of Services. This test verifies that the model is an acceptable representation of the community energy consumption.

TABLE 1

BAD KREUZNACH - 1982 ENERGY BALANCE

GY	NO. 2 OIL GALLONS			NO. 6 OIL GALLONS			COAL METRIC TON			ELECTRIC KWH		
NO	RECORDED	CALCULATED	% DIFF.	RECORDED	CALCULATED	% DIFF.	RECORDED	CALCULATED	% DIFF.	RECORDED	CALCULATED	% DIFF.
026	41,965	36,579	-12.8	---	---	--	---	0	--	88,311	88,610	+ 0.3
057	214,081	211,603	- 1.1	---	---	--	---	0	--	W/GY-727	1,579,074	--
095	10,288	10,407	+ 1.1	---		--	---	2	--	47,969	51,315	+ 7.0
113	---	0		---	---	--	---	0	--	27,438	27,290	- 0.5
160	780,653	723,950	- 7.3	---	---	--	439	353	-19.4	6,012,894	6,260,640	+ 4.1
246	126,331	138,532	+ 9.7	---	---	--	---	0	--	726,848	672,539	- 7.5
335	302,066	268,812	-11.0	---	---	--	---	0	--	1,453,870	1,367,436	- 5.9
478	---	0	---	---	---	--	---		--	44,056	45,101	+ 2.4
510	59,117	82,122	+39.0	301,896	285,716	- 5.3	---	0	--	1,388,400	1,366,648	- 1.6
562	720,747	530,923	-26.3	---	---	--	---	0	--	4,227,000	4,364,408	+ 3.2
615	N/A	12,444	---	---	---	--	---	0	--	394,970	394,899	+ 0.0
727	80,731	86,418	+ 7.0	---	---	--	666	587	-11.9	5,035,884	1,199,375	--
737	23,350	---	---	---	---	--	---	---	--	W/GY-727	---	--
954	9,549	10,469	+ 9.6	---	---	--	---	0	--	209,180	120,157	-42.6
986	10,057	12,864	+27.9	---	---	--	---	0	--	35,403	66,977	+89.0
	2,355,585	2,125,123	-	301,896	285,716	-	1,105	942	-	19,692,223	17,561,289	-

3.6 Community Energy Consumption by Use (Audit)

The energy consumption calculated for the Community was audited to identify both the categories of energy requirements and the quantity of energy in each category. This audit identified the energy requirement impact of each category in relation to the total energy required for the Community. This parameter serves as an indicator in identifying which categories should be analyzed for Energy Conservation Opportunities (ECOs) to effectively reduce the Community energy requirement.

The results of this analysis are presented in Table 2 and are based on the calculated energy consumption.

Several important observations can be made in review of that table as follows:

- In terms of total energy consumption fossil fuel comprises 63.9% of the total, while electricity comprises only 36.1% of the total. In addition, 70.6% of the energy cost is fossil fuel, while electricity comprises only 29.4%.

- Fossil Fuel is consumed primarily in providing facility heat. An examination of the use of fossil fuel indicates that 84% is for facility heat while only 16% is consumed to provide domestic hot water.

- An examination of the use of electricity indicates that Lighting and Receptacle Power comprises 71% of the electrical consumption, each at 32% and 39% respectively. Note is made that use of electricity in these two categories is discretionary and results from occupant use.

- Other use categories of electricity which are noteworthy are Pumps/Fans and Miscellaneous which comprise 17.7% and 7.3% respectively or the total electricity used. The latter is important since it is mission related and cannot be reduced. The former results from the Community heating systems and mess hall kitchen fan systems.

TABLE 2

CALCULATED COMMUNITY ENERGY AUDIT BY USE

ENERGY TYPE/USE	CONSUMPTION MILLION BTU	CONSUMPTION PERCENT OF TOTAL	CONSUMPTION PERCENT BY TYPE	COST DOLLARS	COST PERCENT OF TOTAL
FOSSIL FUEL					
Heating:					
No. 2 Oil	247,571	43.6	68.4	$2,158,819	51.1
No. 6 Oil	41,431	7.3	11.4	256,872	6.1
Coal	22,644	4.0	6.2	128,844	3.1
Subtotal Heating	311,646	54.9	86.0	$2,544,535	60.3
Domestic Hot Water:					
No. 2 Oil	47,183	8.3	13.0	$ 411,436	9.8
No. 6 Oil	63	0	0	391	0
Coal	3,723	0.7	1.0	21,184	0.5
Subtotal DHW	50,969	9.0	14.0	$ 433,011	10.3
Subtotal Fossil Fuel...	362,610	63.9	100.0	$2,977,546	70.6
ELECTRICITY					
Heating	5,196	0.9	2.5	$ 31,332	0.7
Domestic Hot Water	268	0	0	1,616	-
Lighting	70,924	12.5	34.5	427,672	10.1
Power*	78,151	13.7	38.0	471,251	11.2
Pumps/Fans	36,196	6.4	17.7	218,262	5.2
Miscellaneous**	15,046	2.6	7.3	90,727	2.2
Subtotal Electricity...	205,781	36.1	100.0	$1,240,860	29.4
TOTAL	568,396	100%		$4,218,406	100%

ENERGY COST UNITS

No. 2 Oil - $8.72/1,000,000 Btu
No. 6 Oil - 6.20/1,000,000 Btu
Coal - 5.69/1,000,000 Btu
Electricity - 6.03/1,000,000 Btu

* "Power" - Washers, Dryers, Receptacles, Kitchen Equipment (mess hall)

** "Miscellaneous" - Outdoor lights, Radio Transmitters, Air Conditioning, Computers

3.7 Community Energy Consumption by GY Area

The calculated energy consumption for the Community was totalized by GY areas to identify those that are the large consumers of energy. This information is presented as follows:

GY NO.	GY NAME	ENERGY CONSUMING FACILITIES TOTAL NO.	FLOOR AREA SF	PERCENT OF AREA	ENERGY CONSUMPTION MILLION BTU	(%)OF TOTAL	BTU/SF
026	BKAF	6	14,215	0.4	6,102	1.1	429,264
057	AB	34	256,821	7.5	47,666	8.4	185,602
095	MSP	3	8,727	0.2	2,094	0.4	239,945
113	FCP	1	121	0	317	0	2,619,835
160	BKFH	63	1,540,574	43.4	182,916	32.3	118,732
246	MK	13	133,689	3.7	27,015	4.8	202,073
335	BKH	20	437,880	12.3	53,146	9.4	121,371
478	SSP	1	181	0	523	0	2,889,503
510	GCMK	19	205,027	5.7	68,672	12.1	334,941
562	RB	44+1*	675,711	19.1	124,267	21.9	183,906
615	RTSA	11	15,929	0.4	6,307	1.1	395,945
727	DFH	12	229,313	6.4	42,329	7.5	184,590
954	WTOF	8	12,182	0.3	2,846	0.5	233,623
986	BKC	2	21,235	0.6	2,561	0.5	120,603
TOTAL		237+1*	3,551,065	100	566,761	100	159,603 (Avg.)

(*Non-Facility Function)

Summary comments regarding these results are as follows:

- Several GY Areas appear to have a large energy use in terms of BTU/SF. This has resulted from the installation of extensive mission related communications equipment as compared to the amount of floor area. This was found to be the case for GY 026 (Bad Kreuznach A.F.) and GY 615 (Rheingrafenstein).

- A high energy use for GY 113 (Fuerfeld) and GY 478 (Spabruecken) results from the limited facility area.

- Most importantly, GY Areas containing barracks and family housing comprise the larget percentage of facility floor area and the largest percentage of the energy consumed.

TABLE 2

CALCULATED COMMUNITY ENERGY AUDIT BY USE

ENERGY TYPE/USE	CONSUMPTION MILLION BTU	CONSUMPTION PERCENT OF TOTAL	CONSUMPTION PERCENT BY TYPE	COST DOLLARS	COST PERCENT OF TOTAL
FOSSIL FUEL					
Heating:					
No. 2 Oil	247,571	43.6	68.4	$2,158,819	51.1
No. 6 Oil	41,431	7.3	11.4	256,872	6.1
Coal	22,644	4.0	6.2	128,844	3.1
Subtotal Heating	311,646	54.9	86.0	$2,544,535	60.3
Domestic Hot Water:					
No. 2 Oil	47,183	8.3	13.0	$ 411,436	9.8
No. 6 Oil	63	0	0	391	0
Coal	3,723	0.7	1.0	21,184	0.5
Subtotal DHW	50,969	9.0	14.0	$ 433,011	10.3
Subtotal Fossil Fuel...	362,610	63.9	100.0	$2,977,546	70.6
ELECTRICITY					
Heating	5,196	0.9	2.5	$ 31,332	0.7
Domestic Hot Water	268	0	0	1,616	-
Lighting	70,924	12.5	34.5	427,672	10.1
Power*	78,151	13.7	38.0	471,251	11.2
Pumps/Fans	36,196	6.4	17.7	218,262	5.2
Miscellaneous**	15,046	2.6	7.3	90,727	2.2
Subtotal Electricity...	205,781	36.1	100.0	$1,240,860	29.4
TOTAL	568,396	100%		$4,218,406	100%

ENERGY COST UNITS

No. 2 Oil - $8.72/1,000,000 Btu
No. 6 Oil - 6.20/1,000,000 Btu
Coal - 5.69/1,000,000 Btu
Electricity - 6.03/1,000,000 Btu

* "Power" - Washers, Dryers, Receptacles, Kitchen Equipment (mess hall)

** "Miscellaneous" - Outdoor lights, Radio Transmitters, Air Conditioning, Computers

3.7 Community Energy Consumption by GY Area

The calculated energy consumption for the Community was totalized by GY areas to identify those that are the large consumers of energy. This information is presented as follows:

GY NO.	GY NAME	ENERGY CONSUMING FACILITIES TOTAL NO.	FLOOR AREA SF	PERCENT OF AREA	ENERGY CONSUMPTION MILLION BTU	(%)OF TOTAL	BTU/SF
026	BKAF	6	14,215	0.4	6,102	1.1	429,264
057	AB	34	256,821	7.5	47,666	8.4	185,602
095	MSP	3	8,727	0.2	2,094	0.4	239,945
113	FCP	1	121	0	317	0	2,619,835
160	BKFH	63	1,540,574	43.4	182,916	32.3	118,732
246	MK	13	133,689	3.7	27,015	4.8	202,073
335	BKH	20	437,880	12.3	53,146	9.4	121,371
478	SSP	1	181	0	523	0	2,889,503
510	GCMK	19	205,027	5.7	68,672	12.1	334,941
562	RB	44+1	675,711	19.1	124,267	21.9	183,906
615	RTSA	11	15,929	0.4	6,307	1.1	395,945
727	DFH	12	229,313	6.4	42,329	7.5	184,590
954	WTOF	8	12,182	0.3	2,846	0.5	233,623
986	BKC	2	21,235	0.6	2,561	0.5	120,603
TOTAL		237+1*	3,551,065	100	566,761	100	159,603 (Avg.)

(*Non-Facility Function)

Summary comments regarding these results are as follows:

- Several GY Areas appear to have a large energy use in terms of BTU/SF. This has resulted from the installation of extensive mission related communications equipment as compared to the amount of floor area. This was found to be the case for GY 026 (Bad Kreuznach A.F.) and GY 615 (Rheingrafenstein).

- A high energy use for GY 113 (Fuerfeld) and GY 478 (Spabruecken) results from the limited facility area.

- Most importantly, GY Areas containing barracks and family housing comprise the larget percentage of facility floor area and the largest percentage of the energy consumed.

3.8 Community Energy Requirement by Facility Type

The facilities in the Community were grouped by type according to similarity and functional use. The energy requirements for each type were totaled from the energy model calculations. The energy requirements for each facility type are presented as follows:

TYPE CODE/DESCRIPTION	NO. THIS TYPE	TOTAL AREA SF	(%)OF AREA	TOTAL ENERGY MILLION BTU	(%)OF TOTAL	BTU PER SF
A-Admin/Hdqrtrs	28	220,342	6	24,148	6	109,593
B-Barracks	20	593,521	16	55,490	14	93,494
C-Barracks-Admn/Hdqtr	7	90,610	3	10,678	3	117,843
D-Mess	9	131,356	4	35,938	9	273,594
E-Service Club	1	1,535	0	284	0	184,711
F-Repair/Maintenance	24	181,447	5	32,046	8	176,616
G-Recreation	15	133,499	4	21,600	6	161,803
H-Housing	62	1,641,215	46	141,211	36	86,040
I-Training	7	30,106	1	3,288	1	109,222
J-School/Classroom	5	76,276	2	6,125	2	80,302
K-Post Exchange	6	84,767	2	6,291	2	74,214
L-Storage/Warehouse	13	129,753	4	16,036	4	123,590
M-Special Use	8	223,672	6	22,287	6	99,639
N-Electric Heated	32	33,506	1	9,840	3	728,570
Z-Non-Facility Function*	1*	-	-	4,573	1	-
TOTALS	238+1*	3,551,605	100	389,835	100	109,737 (Avg.)

Comments regarding the results of this summary are as follows:

- Living quarters, which include family housing and barracks, comprise 62% of the total Community area and 50% of the total community energy requirement. Family housing comprises 46% and 36%, area to energy and barracks is at 16% and 14% respectively. However, in terms of the BTU/SF both are well below the average for the Community of 109,737.

- The use of electricity for heating occurs in only 1% of the Community area, however it comprises 3% of the Community energy requirement, which results in the highest unit requirement of over 700,000 BTU/SF.

These results are also presented graphically in Appendix Figures A-6, A-7 and A-8.

4.0 PROJECTED ENERGY CONSUMPTION

4.1 Calculated Future Consumption (FY 85)

The energy model was used to calculate a projected consumption of energy for the Community in FY 85. In order to accomplish this it was necessary to modify the facility data and heating plant data to simulate known and funded energy conservation improvements. Any facility expansion projects currently being implemented by the Community or funded with completion projected in time to impact on the FY 85 energy consumption were factored into the energy model.

Data for the projects, i.e., a description and facilities affected, was obtained from the Community. Escalation of fuel costs was based on Government furnished data.

The Projected Energy Consumption and cost for FY 1985 is as follows:

ENERGY SOURCE	CONSUMPTION MILLION BTU	PERCENT OF TOTAL	COST DOLLARS	PERCENT OF TOTAL
Electricity	226,790	39	$1,720,476	32
Distillate Fuel Oil (No. 2)	289,192	50	3,169,230	59
Residual Fuel Oil (No. 6)	38,292	7	298,417	6
Coal	26,059	4	187,131	3
Total	580,333	100	$5,375,254	100

4.2 FY 85 Compliance with AFEP

A comparison of the calculated FY 85 projected energy consumption with the recorded FY 75 energy consumption yields an approximation of compliance with the AFEP as follows:

ENERGY SOURCE	PERCENT CHANGE
Electricity	- 6
Distillate Fuel Oil	- 31
Residual Fuel Oil	- 4
Coal	- 21
Change	- 21

5.0 ENERGY CONSERVATION OPPORTUNITIES

5.1 Energy Conservation Opportunities Considered

Energy Conservation Opportunities considered for evaluation as part of this EEAP were obtained from three sources: Annex "C" of the Scope of Services (USAREUR), K/L past experience on similar energy analyses, and evaluation of existing conditions based on site observations.

Potential ECOs which impact on energy consumption were evaluated using Energy Conservation Investment Program (ECIP) Guidelines to calculate a Savings to Investment Ratio (SIR). When the SIR Value is one (1) or greater the ECO is a candidate for implementation.

5.2 Facility Improvement ECOs (Increment "A")

These ECOs include modifications, improvements and retrofits of existing buildings.

ECOs were evaluated by first performing a preliminary analysis using computer modeled buildings. When this analysis resulted in an acceptable SIR Value, the ECO was evaluated for Community wide implementation.

ECOs evaluated are as follows:

ECO DESCRIPTION	SIR
Facility Space Temperature Reduction	35.6
Insulate Condensate Piping (1" insulation)	8.0
Insulate Condensate Piping (2" Insulation)	4.76
Insulate Valves	1.7
Weatherstrip Doors and Windows	15.5
Weather Responsive Controls	1.2
Reduce Domestic Hot Water Temperature	73.3
Roof Insulation	3.1
Kitchen Hood Air Make-up	1.6
Thermal Curtains - Motor Repair Shops	6.6
Flow Restrictors (DHW)	7.5
Electric Heater Replacement with Oil Heater	21.5
Indoor Lighting, Incandescent to Fluorescent	3.7
Facility Heating Zones	0.5
Wall Insulation (add to existing facilities)	0.9
Double Pane Windows	0.4
Thermal Doors (replace existing)	1.9
Vestibules at Exterior Door.	0.6
Photo Cell Switches - Indoor Lighting.	0.1
Time Clock Control - Indoor Lighting	9.2

ECO DESCRIPTION (Cont'd)	SIR
Outdoor Lighting - Fluorescent to H.P. Sodium.	0.5
Outdoor Lighting - Mercury Vapor to H.P. Sodium. . . .	0.8
High Efficiency Fluorescent Lamps (Relamp)	0.2
Screw Type Fluorescent Lamps (Repl. Incandescent). . .	1.9
High Efficiency Fluorescent Ballasts	.5
Time Clock Control Kitchen Exhausts.	150.0

5.3 Central Plant/Energy Distribution ECOs (Increment "B")

These ECOs include improvements and modifications to utility and energy distribution systems, EMCS systems, and energy plants.

These ECOs were evaluated on an individual basis, i.e., for each central plant where the ECO was considered feasible based on engineering judgement. The analysis results were summarized for each ECO based on implementation at each central plant where the calculated SIR Value was greater than 1.

The ECOs evaluated are as follows:

ECO DESCRIPTION	SIR
Insulate Piping Valves and Tanks	7.2
Boiler Draft Regulators	9.8
Boilers Sequencing Controls	1.4
Interconnect Heating Plants	2.5
Interconnect Central Heating Plants	10.8
Summer Boilers for DHW	3.7
Extended Service Summer Boilers	1.2
Jet Condensate Pumps	1.1
Load Limiting Device	12.4
Coal-Fired Boiler Conversion	0.6
Replace Inefficient Boilers	1.3
Convert Heating Medium Distributed	2.3
Down Size Burners	0.35
Combustion Air Preheaters	0.30
Recover Heat from Blowdown	1.0
Carrier Current Control System	1.9
Energy Monitoring and Control Systems	0.65

5.4 Recommended Energy Conservation Opportunities

A total of 25 Energy Conservation Opportunities, which meet ECIP Criteria, were recommended for implementation in the Community. These ECOs are presented in Table 3 with the results of the economic analyses performed for each ECO which had an SIR greater than 1.

TABLE 3

LIST OF RECOMMENDED ECO's WITH COMMUNITY WIDE ESIR OR SIR >1

RANK	ECO DESCRIPTION	INCREMENT	ENERGY SAVINGS (MMBTU)	COST SAVING ($)	DISCOUNTED SAVING ($)	INVESTMENT COST ($)	SIR	ESIR
1	Reduce Domestic Hot Water Temperature	A	4,620	39,810	454,700	6,200	73.3	73.3
2	Building Space Temperature Reduction	A	79,150	666,300	7,771,100	216,000	36.0	36.0
3	Replace Electric Heaters W/Oil Heaters	A	8,700	49,200	538,000	25,000	21.5	21.5
4	Weatherstrip Doors & Windows	A	7,120	60,000	697,000	45,000	15.5	15.5
5	Install Load Limit Device on Htg. Plant	B	1,560	9,400	124,000	10,000	12.4	12.4
6	Interconnect Central Plants	B	27,640	239,540	2,711,160	250,000	10.8	10.8
7	Install Draft Regulators	B	2,040	16,940	197,000	20,000	9.8	9.8
8	Repl.Lighting Indoor Incand.W/Fluor.	A	3,925	20,100	215,950	25,000	8.7	8.7
9	Insulate Condensate Piping	A	580	4,850	55,900	7,000	8.0	8.0
10	Insulate Piping and Vessels-Central Plnts	B	1,890	15,280	178,810	24,500	7.2	7.2
11	Thermal Curtains at Motor Repair Shops	A	11,640	101,400	1,152,000	160,000	6.6	6.6
12	Install Summer Boilers	B	1,550	13,310	151,200	42,000	3.6	3.6
13	Flow Restrictors DHW	A	4,060	24,500	326,000	100,400	3.2	3.2
14	Install Roof Insulation	A	45,650	350,700	4,445,000	1,413,000	3.1	3.1
15	Interconnect Existing Facility Htg. Plants	B	2,660	28,700	281,600	111,000	2.5	2.5
16	Distribute more efficient Htg. Medium	B	290	1,700	23,000	9,800	2.4	2.4
* 17	Install Carrier Current Control	G	-0-	75,200	827,950	443,600	1.8	1.8
18	Insulate Valves in Facilities	A	370	3,120	35,650	21,000	1.7	1.7
19	Kitchen Hood Makeup Air	A	4,730	41,200	470,000	300,000	1.6	1.6
20	Install Boiler Sequencing Devices	B	225	1,960	22,230	16,300	1.4	1.4
21	Boiler Replacement	B	310	2,800	31,800	24,000	1.3	1.3
** 22	Install Extended Serv. Summer Boilers	B	750	6,450	73,300	61,000	1.2	1.2
23	Install Weather Responsive Controls	A	10,060	86,000	986,000	830,000	1.2	1.2
24	Install Jet Condensate Pumps	B	1,320	7,950	106,000	97,000	1.1	1.1
25	Boiler Blowdown Heat Recovery	B	120	710	9,400	9,000	1.0	1.0

* This ECO does not save energy it limits demand which results in reduced demand charges.

**This ECO will not be considered for implementation since it occurs for the same facilities as the Summer Boiler ECO which has a higher SIR Value and results in more energy savings.

ECOs, which met ECIP criteria but were not recommended for implementation are as follows:

- New Thermal Doors - ECO for weatherstripping resulted in a higher SIR.
- Time Clock Controls - Field data observations indicated that time clocks were not required for either indoor lights or kitchen exhausts.
- Screw-in Type Fluorescent Lamps - Application limited to fixtures without a lens housing, i.e., typically table lamps found in family housing, therefore implementation would have to be through occupants.

5.5 ECIP Projects

ECIP projects include those Energy Conservation Opportunities which, when grouped together in accordance with the Community's requests, meet Energy Conservation Investment Program criteria and can therefore be implemented through ECIP funding.

DD 1391 Forms and Project Development Brochures (PDP-1's) were subsequently prepared for each project which incorporate a conversion rate of $1=2.56 DM and an annual escalation rate of 8%. The projects were programmed for funding in FY 87.

The projects are listed in order of decreasing SIR Value as follows:

PROJECT RANK/NO.	PROJECT DESCRIPTION	ECO NO.	INCRE-MENT	FACILITY TYPE	FUNDING $ x 1000	PROJECT SIR	PROJECT ESIR
1	Attic/Roof Insulation	14	A	MCA	1,427.9	3.08	3.08
2	Attic/Roof Insulation	14	A	FH	564.8	2.63	2.63
3	Kitchen Hood/Make-up Air	19	A	MCA	423.8	1.67	1.67
4	Weather Responsive Cont.	23	A	MCA	1,051.9	1.06	1.06
5	Weather Responsive Cont.	23	A	FH	185.9	1.01	1.01

5.6 Other Projects

"Other Projects" include all other Energy Conservation Opportunities which, when grouped together in accordance with the Community's request, do not meet Energy Conservation Investment Program criteria and, therefore cannot be ECIP funded.

The project documentation prepared for these projects in accordance with the Community request include "1391/PDB-1" documents and "4283" (Work Order) documents. Special note is made that multiple "4283's" were prepared for each project; a "4283" was prepared for each heating plant; for the other projects a separate "4283" was prepared for each GY Area where the ECO was to be implemented.

TABLE 3

LIST OF RECOMMENDED ECO's WITH COMMUNITY WIDE ESIR OR SIR >1

RANK	ECO DESCRIPTION	INCREMENT	ENERGY SAVINGS (MMBTU)	COST SAVING ($)	DISCOUNTED SAVING ($)	INVESTMENT COST ($)	SIR	ESIR
1	Reduce Domestic Hot Water Temperature	A	4,620	39,810	454,700	6,200	73.3	73.3
2	Building Space Temperature Reduction	A	79,150	666,300	7,771,100	216,000	36.0	36.0
3	Replace Electric Heaters W/Oil Heaters	A	8,700	49,200	538,000	25,000	21.5	21.5
4	Weatherstrip Doors & Windows	A	7,120	60,000	697,000	45,000	15.5	15.5
5	Install Load Limit Device on Htg. Plant	B	1,560	9,400	124,000	10,000	12.4	12.4
6	Interconnect Central Plants	B	27,640	239,540	2,711,160	250,000	10.8	10.8
7	Install Draft Regulators	B	2,040	16,940	197,000	20,000	9.8	9.8
8	Repl.Lighting Indoor Incand.W/Fluor.	A	3,925	20,100	215,950	25,000	8.7	8.7
9	Insulate Condensate Piping	A	580	4,850	55,900	7,000	8.0	8.0
10	Insulate Piping and Vessels-Central Plnts	B	1,890	15,280	178,810	24,500	7.2	7.2
11	Thermal Curtains at Motor Repair Shops	A	11,640	101,400	1,152,000	160,000	6.6	6.6
12	Install Summer Boilers	B	1,550	13,310	151,200	42,000	3.6	3.6
13	Flow Restrictors DHW	A	4,060	24,500	326,000	100,400	3.2	3.2
14	Install Roof Insulation	A	45,650	350,700	4,445,000	1,413,000	3.1	3.1
15	Interconnect Existing Facility Htg. Plants	B	2,660	28,700	281,600	111,000	2.5	2.5
16	Distribute more efficient Htg. Medium	B	290	1,700	23,000	9,800	2.4	2.4
* 17	Install Carrier Current Control	G	-0-	75,200	827,950	443,600	1.8	1.8
18	Insulate Valves in Facilities	A	370	3,120	35,650	21,000	1.7	1.7
19	Kitchen Hood Makeup Air	A	4,730	41,200	470,000	300,000	1.6	1.6
20	Install Boiler Sequencing Devices	B	225	1,960	22,230	16,300	1.4	1.4
21	Boiler Replacement	B	310	2,800	31,800	24,000	1.3	1.3
** 22	Install Extended Serv. Summer Boilers	B	750	6,450	73,300	61,000	1.2	1.2
23	Install Weather Responsive Controls	A	10,060	86,000	986,000	830,000	1.2	1.2
24	Install Jet Condensate Pumps	B	1,320	7,950	106,000	97,000	1.1	1.1
25	Boiler Blowdown Heat Recovery	B	120	710	9,400	9,000	1.0	1.0

* This ECO does not save energy it limits demand which results in reduced demand charges.

**This ECO will not be considered for implementation since it occurs for the same facilities as the Summer Boiler ECO which has a higher SIR Value and results in more energy savings.

ECOs, which met ECIP criteria but were not recommended for implementation are as follows:

- New Thermal Doors - ECO for weatherstripping resulted in a higher SIR.
- Time Clock Controls - Field data observations indicated that time clocks were not required for either indoor lights or kitchen exhausts.
- Screw-in Type Fluorescent Lamps - Application limited to fixtures without a lens housing, i.e., typically table lamps found in family housing, therefore implementation would have to be through occupants.

5.5 ECIP Projects

Energy Conservation Opportunities were grouped into projects for ECIP funding in accordance with the Community requests. The funding for the ECOs is programmed for FY 87. A conversion rate of $1 = 2.56 DM was used with an escalation rate of 8% annually to determine the funding request. DD 1391 Documents and Project Development Brochures (PDB-1's) were prepared for each project, which are listed in order of decreasing SIR Value as follows:

PROJECT RANK/NO.	PROJECT DESCRIPTION	ECO NO.	INCREMENT	FACILITY TYPE	FUNDING $ x 1000	PROJECT SIR	PROJECT ESIR
1	Attic/Roof Insulation		A	MCA	1,427.9	3.08	3.08
2	Attic/Roof Insulation		A	FH	564.8	2.63	2.63
3	Kitchen Hood/Make-up Air		A	MCA	423.8	1.67	1.67
4	Weather Responsive Cont.		A	MCA	1,051.9	1.06	1.06
5	Weather Responsive Cont.		A	FH	185.9	1.01	1.01
6	Carrier Current Control		B	MCA/FH	484.0	1.77	-

5.6 Other Projects

In accordance with the Community request, all remaining ECOs which could not be grouped into projects for ECIP Funding, were grouped into projects for funding as "Work Order" (4283) Projects.

"4283" documents were prepared for each project; for the heating plant improvement project, a "4283" was prepared for each heating plant; for the other projects a separate "4283" was prepared for each GY Area where the ECO was to be implemented.

The documents developed are as follows:

PROJECT RANK/NO.	PROJECT DESCRIPTION	ECO NO.	DOCUMENT TYPE	INCREMENT	FACILITY TYPE FUNDING $x1000 MCA	FH	PROJECT SIR	ESIR
1	Space Temp. Reduc.	2	4283	G	196.4	68.6	36.0	36.0
2	Elec/Oil Htr. Conv.	3	4283	G	29.1	-	21.5	21.5
3	Fluorescent Lamps	8	4283	G	-	102.8	8.7	8.7
4	DHW Flow Restrictors	13	4283	G	24.5	73.1	3.2	3.2
5	Heating Plant Improvements	5,7,11 20,24,25	4283	G	281.9	-	2.99	2.99
6	Carrier Current Control	17	1391	G	-	484.0	1.77	-
7	Insulate Valves		4283	G	21.6	3.8	1.7	1.7
8	DHW - Summer Boilers	12	4283	G	49.4	-	1.45	1.45

5.7 Energy Consumption with ECOs Implemented

Energy consumption for the Community was calculated using the energy model modified to reflect implementation of the ECOs recommended. The results of that analysis yielded a resulting energy consumption as follows:

ENERGY SOURCE	CONSUMPTION BTU X 10^6	PERCENT OF TOTAL	COST DOLLARS	PERCENT OF TOTAL
Electricity	177,950	48	$1,580,075	41
Distillate Fuel Oil	148,995	40	1,901,382	49
Residual Fuel Oil	28,952	8	263,563	7
Coal	13,155	4	110,192	3
Total	369,052	100	$3,855,212	100

5.8 Compliance with AFEP

With the implementation of the energy conservation opportunities recommended, the change in energy consumption as compared to the "Baseline Consumption" for FY 75 will be as follows:

ENERGY SOURCE	PERCENT CHANGE
Electricity	- 26
Distillate Fuel Oil	- 65
Residual Fuel Oil	- 28
Coal	- 60
Change	- 50

Appendix Figures A-9 and A-10 graphically present the change in consumption and cost from FY 75 to FY 85 with ECOs for each energy type.

6.0 COMMUNITY IMPLEMENTED ENERGY CONSERVATION MEASURES

6.1 Operational & Maintenance Procedures

Operational and maintenance measures should be performed on a scheduled basis in order to yield in energy savings. Measures identified requiring implementation by the Community are as follows:

- Maintenance program for all mechanical and electrical equipment.
- Adjust and/or clean oil boiler burners.
- Perform boiler combustion efficiency tests with electronic instruments.
- Check equipment time clock operation and settings.
- Check weather responsive controls setback schedule.
- Inspect steam traps.
- Provide water treatment for boiler water makeup.
- Perform boiler blowdown to remove mineral deposits.
- Recalibrate central plant instrumentation.
- Install electric meters in Family Housing/Barracks.

6.2 Building Occupant Energy Awareness Programs

Facility occupants should be made aware of methods that they can implement to reduce energy waste, these are:

- Shut off lights and equipment when not used.
- Close radiator valves, lower thermostats. Do not open windows in winter.
- Lower space temperature when out of building.

6.3 Training

The central plant operators must be thoroughly trained in the operation of the boiler plants. Training instruction/courses are available for operators from the following sources:

- Boiler Efficiency Institute", P.O. Box 2255, Auburn, Alabama, USA (36830)

- Viessmann Boiler Co., 2-day instruction at Facility or Viessmann Offices, Fee 2800 DM. Contact Mr. Hencker (0611-692033-35)

6.4 Equipment Replacement

When existing equipment fails due to age or condition, the replacement equipment selected should be high efficiency types to obtain energy savings. Examples of this are:

- Relamp with high efficiency "WATTMISER" fluorescent lamps.

"4283" documents developed are as follows:

PROJECT RANK/NO.	PROJECT DESCRIPTION	ECO NO.	INCRE-MENT	FACILITY TYPE FUNDING $ x 1000 MCA	FH	PROJECT SIR	ESIR
1	Space Temp. Reduc.	2	A	196.4	68.6	36.0	36.0
2	Elec/Oil Htr. Conv.	3	A	29.1	-	21.5	21.5
3	Heating Plant Improvements	5,7,11 20,24,25	B	281.9	-	2.99	2.99
4	DHW - Summer Boilers	12	B	49.4	-	1.45	1.45
5	Fluorescent Lamps	8	A	-	102.8	8.7	8.7
6	Insulate Valves		A	21.6	3.8	1.7	1.7
7	DHW Flow Restrictors	13	A	24.5	73.1	3.2	3.2

5.7 Energy Consumption with ECOs Implemented

Energy consumption for the Community was calculated using the energy model modified to reflect implementation of the ECOs recommended. The results of that analysis yielded a resulting energy consumption as follows:

ENERGY SOURCE	CONSUMPTION BTU X 10^6	PERCENT OF TOTAL	COST DOLLARS	PERCENT OF TOTAL
Electricity	177,950	48	$1,580,075	41
Distillate Fuel Oil	148,995	40	1,901,382	49
Residual Fuel Oil	28,952	8	263,563	7
Coal	13,155	4	110,192	3
Total	369,052	100	$3,855,212	100

5.8 Compliance with AFEP

With the implementation of the energy conservation opportunities recommended, the change in energy consumption as compared to the "Baseline Consumption" for FY 75 will be as follows:

ENERGY SOURCE	PERCENT CHANGE
Electricity	- 26
Distillate Fuel Oil	- 65
Residual Fuel Oil	- 28
Coal	- 60
Change	- 50

Appendix Figures A-9 and A-10 graphically present the change in consumption and cost from FY 75 to FY 85 with ECOs for each energy type.

6.0 COMMUNITY IMPLEMENTED ENERGY CONSERVATION MEASURES

6.1 Operational & Maintenance Procedures

Operational and maintenance measures should be performed on a scheduled basis in order to yield in energy savings. Measures identified requiring implementation by the Community are as follows:

- Maintenance program for all mechanical and electrical equipment.
- Adjust and/or clean oil boiler burners.
- Perform boiler combustion efficiency tests with electronic instruments.
- Check equipment time clock operation and settings.
- Check weather responsive controls setback schedule.
- Inspect steam traps.
- Provide water treatment for boiler water makeup.
- Perform boiler blowdown to remove mineral deposits.
- Recalibrate central plant instrumentation.
- Install electric meters in Family Housing/Barracks.

6.2 Building Occupant Energy Awareness Programs

Facility occupants should be made aware of methods that they can implement to reduce energy waste, these are:

- Shut off lights and equipment when not used.
- Close radiator valves, lower thermostats. Do not open windows in winter.
- Lower space temperature when out of building.

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The central plant operators must be thoroughly trained in the operation of the boiler plants. Training instruction/courses are available for operators from the following sources:

- Boiler Efficiency Institute", P.O. Box 2255, Auburn, Alabama, USA (36830)

- Viessmann Boiler Co., 2-day instruction at Facility or Viessmann Offices, Fee 2800 DM. Contact Mr. Hencker (0611-692033-35)

6.4 Equipment Replacement

When existing equipment fails due to age or condition, the replacement equipment selected should be high efficiency types to obtain energy savings. Examples of this are:

- Relamp with high efficiency "WATTMISER" fluorescent lamps.
- New boilers size should match current peak heating load requirement and not existing boiler nameplate data.

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- Replace faulty boiler burners with proper efficient units to match load.
- Install separate domestic hot water heaters for summer requirements so so that base heating plant boilers can be shut-down in the summer.
- Install controls to limit domestic hot water to 105°F.
- Install high efficiency motors.
- Replace steam heating systems with hot water when renovating.
- Install high efficiency ballasts in fluorescent fixtures.
- Install tamperproof radiator valves that fail closed.
- Relamp incandescent fixtures with screw-in type fluorescent lamps.
- Install electrical transformers matched to recorded demand peaks.

7.0 SUMMARY AND RECOMMENDATIONS

7.1 General

The objective of this project is to reduce energy consumption by the Community in accordance with the goals of the Army Facilities Energy Plan (AFEP). Specifically, this plan calls for reducing consumption such that the FY 85 consumption is 20% below the FY 75 consumption.

7.2 Existing Energy Situation

Energy consumption for FY 75 was designated to be the "Baseline Consumption." From Community records it was found that in FY 75, the Community had consumed $736,304 \times 10^6$ Btu's of energy at a cost of $2,329,301.

By FY 82, when this study was performed, energy consumption had changed to $663,920 \times 10^6$ Btu, which was a net 10% decrease below the consumption of FY 75. In addition, energy cost had changed to $4,876,746. Consumption had remained at the same level since the Community has implemented energy conservation measures to reduce the consumption of fossil fuel which offset an increased consumption of electrical energy.

Physical changes are planned for the Community which will affect future consumption. Those changes include conservation measures consisting of facility improvements and also heating plant consolidation, which will result in a reduction of consumption. However, projects are also planned which will increase the Community facility area and thus increase consumption. Those funded, were programmed into the energy model to project consumption for FY 85. The net results include a decrease in total consumption by FY 85 to $580,333 \times 10^6$ Btu with a projected cost of $5,375,254.

The change in consumption is summarized as follows:

FY YEAR	TOTAL CONSUMPTION MILLION BTU	PERCENT CHANGE SINCE FY 75
75	736,304	
82	666,970	- 9.4
85	580,333	- 21.2

In review of this it can be seen that compliance with the AFEP, i.e., reduction of 20% by FY 85 will be achieved under the current Community plans. However, this reduction has really resulted from full deactivation of GY 791 (Dichtelbach), partial deactivation GY 954 (Wueschheim Tactical) and transfer of GY 790 (Wueschheim Missile) to the Air Force.

7.3 Community Energy Audit

A computerized energy model was developed for the Community. This model served two purposes: it provided a means to evaluate the impact of ECOs on Community energy consumption and in addition, it provided a means to perform an audit of the Community energy consumption to determine how energy is used and conversely where reduction should be made.

Based on the audit, the major categories of consumption, ranked by quantity are as follows:

NO./RANK	ENERGY CATEGORY	PERCENT OF TOTAL ENERGY
1	Facility Heat	55.8
2	Receptacle Power	13.7
3	Facility Lighting	12.5
4	Domestic Hot Water Heating	9.0
5	Distribution Equipment Power (Pum/Fans)	6.4
6	Miscellaneous Power	2.6

It was also determined from the audit that by energy source, fossil fuel (categories 1 and 4), comprises 64% of the energy consumed and electricity the remaining 36%.

7.4 Energy Conservation Opportunities (ECO)

The greatest amount (63.9%) of energy consumed by the Community is in the form of fossil fuel for heating of facilities and domestic hot water. Many ECOs were identified and, based on evaluation results, were found to quality for implementation and thus reduce the consumption of fossil fuel. These ECOs included bringing facilities and systems into compliance with Army mandated temperatures (i.e., facilities at 65°F during the day and 55°F at night), increasing the

- Replace faulty boiler burners with proper efficient units to match load.
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thermal resistance of facilities by installing insulation, modification and consolidation of heating plants to increase system efficiencies, and lastly adding controls to heating systems to use the heating media more effectively. Through implementation of these measures, fossil fuel consumption will reduce to 51% of the total, with its change since FY 75 presented as follows:

FY YEAR	CONSUMPTION FOSSIL FUEL MILLION BTU	(%)of TOTAL	PERCENT CHANGE FROM FY75
75	429,271	58%	-
82	398,079	60%	- 19%
85	353,543	61%	- 28%
with ECOs	200,332	51%	- 60%

Electricity comprises 36.1% of the total energy currently consumed in the Comunity. The use categories of electrical energy are as follows: receptacle power (13.7%), facility lighting (12.5%), heating media distribution equipment power (6.4%), miscellaneous (mission related) systems (2.6%), facility heat (0.9%) and domestic hot water (negligible). Many ECOs were identified and, based on evaluation, some do qualify for implementation, however, there is a real lack of physical improvements in the form of ECOs impacting on consumption.

The apparent reason of this lack of ECO projects can be traced to the categories of electrical energy use. Specifically, the primary categories having an impact, are receptacle power and facility lighting, which comprise 13.7% and 12.5% respectively of the 36.1% total. ECOs were developed for these categories that include installation of more efficient fluorescent lighting to reduce energy consumption and a carrier current control system which will reduce electrical demand cost but not consumption. Other ECOs were not found to be cost effective. In addition, the energy consumption in these two categories is totally discretionary; receptacles and lights are controlled by facility occupants. Since family housing and barracks comprise 62% of the total floor area and 50% of the total energy consumption, the impact of the many appliances (TV's, stereos, video cassette recorders, phonographs, refrigerators and especially electric clothes dryers) is significant.

With regards to the other categories, the distribution equipment consists for the most part of pumps distributing hot water for heating to the facilities. The miscellaneous use is for the most part mission related consisting of communication equipment and security lighting. Reduction in either of these categories is not feasible.

The remaining electrical ECO is for the installation of oil heaters in Facilities (mostly Sentry Stations) which are currently electrically heated. While this ECO will reduce electrical consumption it will result in an increase of fuel oil consumption. Savings will be realized since fuel oil is a less expensive form of energy than electricity.

Through implementation of the ECO projects identified, electrical energy consumption will decrease from the projected FY 85 level. The change in electrical consumption since FY 75 is presented as follows:

FY YEAR	ELEC. CONSUMPTION MILLION BTU	(%)OF TOTAL	PERCENT CHANGE SINCE FY 75
75	242,033	33	-
82	265,891	40	+ 10%
85	226,970	39	- 6%
With ECOs	191,542	49	- 21%

7.5 Impact on Energy Situation/AFEP Compliance

The impact of implementation of ECOs on the energy situation in the Community is presented as follows:

FY YEAR	TOTAL CONSUMPTION MILLION BTU	PERCENT CHANGE SINCE FY 75
75	736,304	-
82	666,970	- 9.0
85	580,333	- 21.0
With ECOs	391,874	- 47.0

In summary, while it will be possible to achieve compliance with the Army Facilities Energy Plan (AFEP) by FY 85, compliance will be related to the deactivation or release of high energy consuming GY Areas. By implementation of the ECO projects recommended energy consumption will be drastically reduced 47% below the FY 75 consumption through energy conservation. This reduction greatly exceeds the 20% required by the AFEP. Figure 1 graphically presents the impact of the energy savings on the total consumption occurring for FY 75.

7.6 Recommendations

K/L recommends that all ECO projects be implemented after funding is approved.

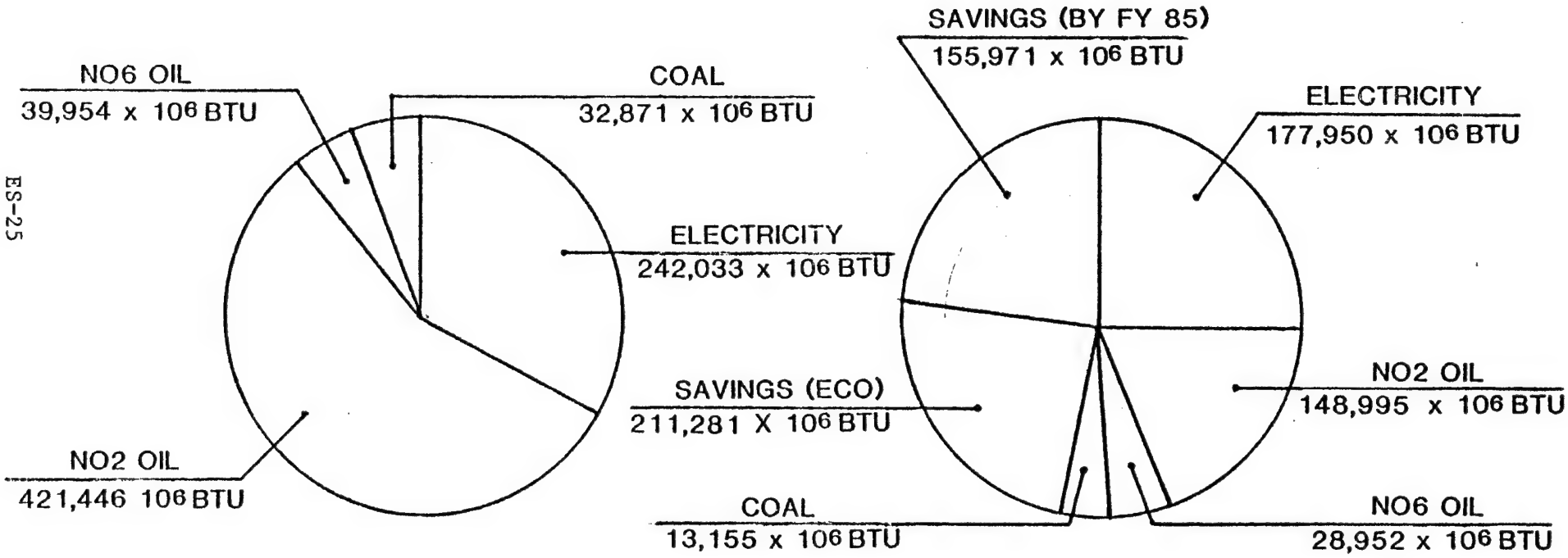
K/L recommends that emphasis be placed on reducing consumption of fossil fuel in heating plants where thermal energy is released to heat Facilities and domestic hot water. Further reductions in energy use can be made consolidating individual heating plants to central plants (not part of this study) without adverse impact on troop morale or mission.

Reduction in electrical energy consumption is limited; due to its discretionary use by troops and/or dependents and required use for mission related systems. Further reductions in consumption is possible through energy awareness programs, where troops and dependents are made aware of the impact of leaving lights and appliances on when not in use. Efforts to reduce consumption by enforcing restrictions may have an adverse affect on troop morale.

FIGURE 1

TOTAL ENERGY CONSUMPTION

FY 75 VS FY 85 W/ECOs



FY 75	FY 85 W/ECOs
CONSUMPTION 736,304 x 10⁶ BTU	CONSUMPTION 369,052 x 10⁶ BTU
	TOTAL SAVINGS 367,252 x 10⁶ BTU

TABLE A-1

TYPICAL COMPUTER MODELED FACILITIES

BLDG NO.	GY NO. NAME	TYPE	BUILDING FUNCTION	AREA SQ.FT.	ENERGY TYPE AND REQUIREMENT (BTU/SQ.FT.) FOSSIL FUEL HEATING	FOSSIL FUEL DOM H W	ELECTRICITY LIGHT	ELECTRICITY POWER	ELECTRICITY PUMPS	ELECTRICITY DOM H.W	ELECTRICITY HEATING	TOTAL
5200	296 MK	D	ENL PERS MESS	19,824	89,437	19,925	36,852	28,112	23,176	-0-	-0-	197,502
5202	296 MK	A	CO HQ BLDG	2,163	162,274	-0-	26,075	2,344	-0-	-0-	-0-	190,693
5204	296 MK	F	MOTOR REPAIR SHOP	10,851	117,041	-0-	33,035	1,446	17,844	-0-	-0-	169,366
5212	296 MK	C	BN HQ-BKS W/O MESS	24,088	48,697	11,334	15,696	5,212	12,166	-0-	-0-	93,105
5214	296 MK	A	ENGR ADMIN BLDG	3,949	76,728	-0-	15,034	6,815	-0-	-0-	-0-	98,577
5240	026 BKAF	M	AF OPS BLDG	8,042	258,890	373	9,597	3,012	7,988	-0-	-0-	279,860
5253	335 BKH	M	ADMIN-DENTL FAC	55,398	40,724	1,065	10,382	3,982	8,543	-0-	-0-	56,153
5260	335 BKH	J	COLD STORAGE WHSE	22,287	36,166	628	14,228	3,557	-0-	-0-	-0-	54,579
5337	562 RB	N	SENTRY STATION	129	-0-	-0-	60,518	-0-	-0-	-0-	1,218,899	1,279,417
5556	510 GCMK	L	GEN'L PURPOSE WHSE	22,831	76,694	44	26,523	2,664	-0-	-0-	-0-	105,925
5564	510 GCMK	M	LAUNDRY	44,289	23,188	324,211	18,992	44,636	74,343	-0-	-0-	485,370
5565	510 GCMK	M	COLD STORAGE WHSE	5,010	-0-	-0-	13,959	291,204	22,920	-0-	-0-	328,083
5572	510 GCMK	F	FAC ENGR MAINT SHOP	21,389	97,013	-0-	11,951	39,764	-0-	-0-	-0-	148,728
5600	160 BKFH	H	FAM HSG NCO	27,387	38,777	7,595	11,849	14,671	8,849	-0-	-0-	81,741
5603	160 BKFH	H	FAM HSG LTC AND MAJ	15,468	44,867	4,267	12,227	29,050	4,857	-0-	-0-	92,268
5621	160 BKFH	J	DEPN GRADE SCHOOL	40,901	56,209	269	30,436	672	10,424	-0-	-0-	98,010
5623	160 BKFH	H	FAM HSG LTC/MAJ	11,119	56,120	7,285	12,458	17,053	-0-	-0-	-0-	92,916
5632	160 BKFH	H	FAM HSG NCO	37,150	30,013	7,026	19,601	21,253	12,644	-0-	-0-	90,537
5649	160 BKFH	H	GUEST HOUSE	11,601	43,186	10,775	11,598	19,077	-0-	-0-	-0-	84,636
5653	160 BKFH	G	YOUTH CENTER	7,888	82,530	2,282	28,349	6,781	-0-	-0-	-0-	119,942
5657	160 BKFH	H	FAM HSG LTC/MAJ	9,983	66,513	5,509	14,732	18,933	-0-	-0-	-0-	105,687
6308	057 AB	B	BKS W/O MESS	22,184	22,088	18,662	39,759	17,550	-0-	-0-	-0-	98,059
6338	057 AB	B	BKS W/O MESS	32,400	19,938	27,531	25,964	10,368	-0-	-0-	-0-	83,801
6350	727 DFH	H	FAM HSG NCO	27,471	57,661	6,698	10,305	23,312	30,774	-0-	-0-	128,750
4002	100*	B	BKS W/O MESS	52,477	33,310	15,883	20,794	13,272	-0-	-0-	-0-	83,259
4005	100*	A	DIV HQ BLDG	60,052	27,793	2,614	14,285	4,886	-0-	-0-	-0-	49,578
4006	100*	C	ADMIN-BKS W/O MESS	52,595	31,466	6,579	35,222	24,547	-0-	-0-	-0-	97,815
4008	100*	E	EM SERVICE CLUB	12,894	76,624	6,282	30,438	99,550	-0-	-0-	-0-	212,894
4013	100*	D	ENL PERS MESS	25,832	117,064	40,260	44,174	94,925	-0-	-0-	-0-	296,424
4017A	100*	G	BOWLING CENTER	19,875	54,943	-0-	2,890	32,363	-0-	-0-	-0-	90,196
4017B	100*	G	GYMNASIUM	26,505	78,929	34,597	18,577	17,201	-0-	-0-	-0-	149,303
4019	100*	L	GEN STORE HOUSE	15,503	33,947	731	5,361	5,383	-0-	-0-	-0-	45,421
4020A	100*	G	REC BLDG	12,038	56,155	5,316	14,852	150,625	-0-	-0-	-0-	226,949
4020B	100*	D	OPEN MESS NCO	3,868	88,676	5,688	15,610	146,769	-0-	-0-	-0-	256,743
4020C	100*	M	FIXED LAUNDRY	2,705	39,926	21,072	16,622	933,197	-0-	-0-	-0-	1,010,817
4021	100*	G	THEAT W/STAGE	16,783	69,356	179	11,080	1,992	-0-	-0-	-0-	82,607
4027	100*	A	POST HQ/ADMIN	29,015	23,540	172	45,014	25,976	-0-	-0-	-0-	94,702
4090	806*	H	SEBQ	11,751	51,910	25,019	23,238	36,267	-0-	-0-	-0-	136,434
4092	806*	H	BOQ	29,486	42,936	8,852	23,756	22,952	-0-	-0-	-0-	98,495
4106B	313*	A	ENGR ADMIN	8,052	5,216	-0-	31,704	8,023	-0-	-0-	-0-	44,943
4127	313*	F	FAC ENGR STORHSE	11,150	109,058	-0-	8,519	25,831	-0-	-0-	-0-	143,409
4165	377*	B	BKS W/O MESS	54,882	28,024	11,862	19,882	12,691	-0-	-0-	-0-	72,459
4233A	143*	K	CLO SALES STORE	1,659	7,836	4,822	10,188	24,787	-0-	-0-	-0-	47,633
4233B	143*	I	SKILL DEV CNTR	6,903	1,449	579	26,245	89,928	-0-	-0-	-0-	118,201
4233C	143*	I	GEN EDUCATN DEV FAC	13,806	19,050	290	12,436	7,257	-0-	-0-	-0-	39,032
4233D	143*	K	POST EXCHANGE	5,244	5,721	11,823	4,329	70,533	-0-	-0-	-0-	92,406
4319	014*	A	ADMIN	41,199	63,642	631	30,360	36,462	-0-	-0-	-0-	131,097
4363	908*	I	GEN EDUCATN DEV FAC	24,190	24,101	11,410	31,528	25,398	7,337	-0-	-0-	99,773
4451	807*	H	FAM HSG LTC/MAJ	4,384	51,323	29,653	15,347	26,145	-0-	-0-	-0-	122,468
4508	069*	A	GP HQ BLDG/ADMIN	12,738	73,716	-0-	29,596	16,060	-0-	-0-	-0-	119,372
4523	069*	F	MOTOR REPAIR SHOP	23,836	94,688	-0-	29,111	3,950	24,058	-0-	-0-	151,809

*GY Areas located in Darmstadt Military Community

FIGURE A-1

TOTAL ENERGY CONSUMPTION BY GY AREA
(FY 75 vs FY 82)

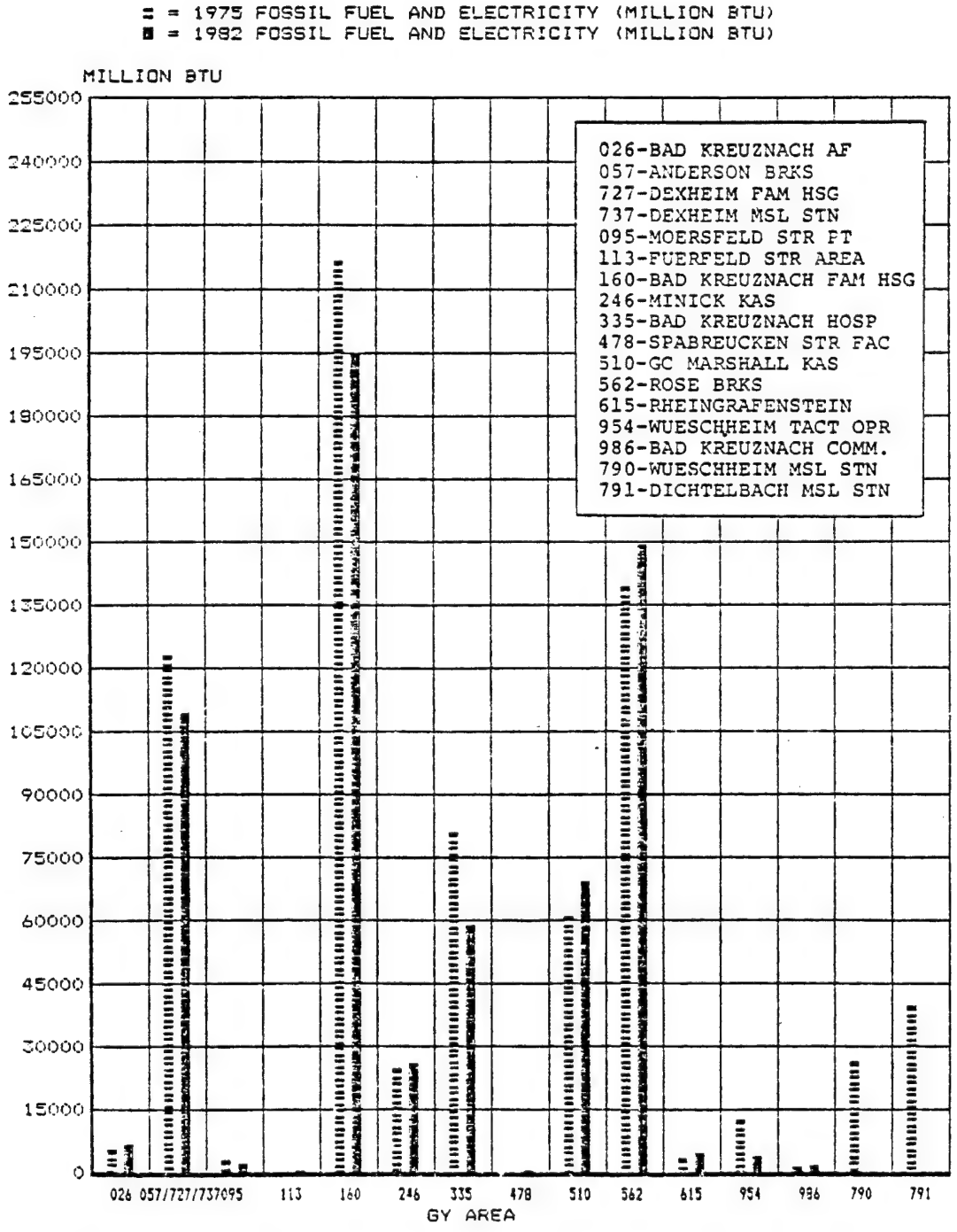


FIGURE A-2

TOTAL ENERGY CONSUMPTION/SF BY GY AREA
(FY 75 vs FY 82)

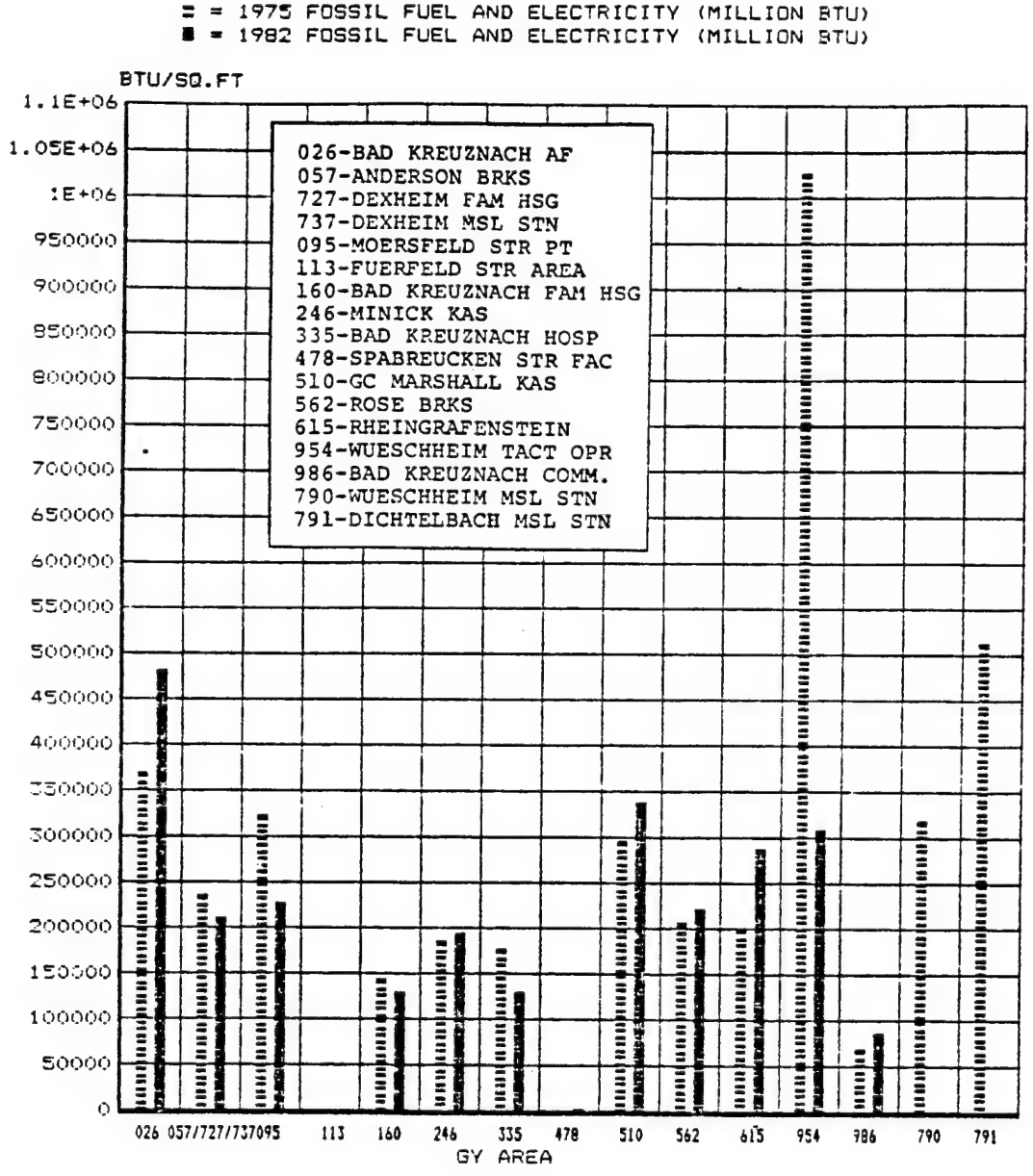


FIGURE A-3

COAL CONSUMPTION BY GY AREA
(FY 75 vs FY 82)

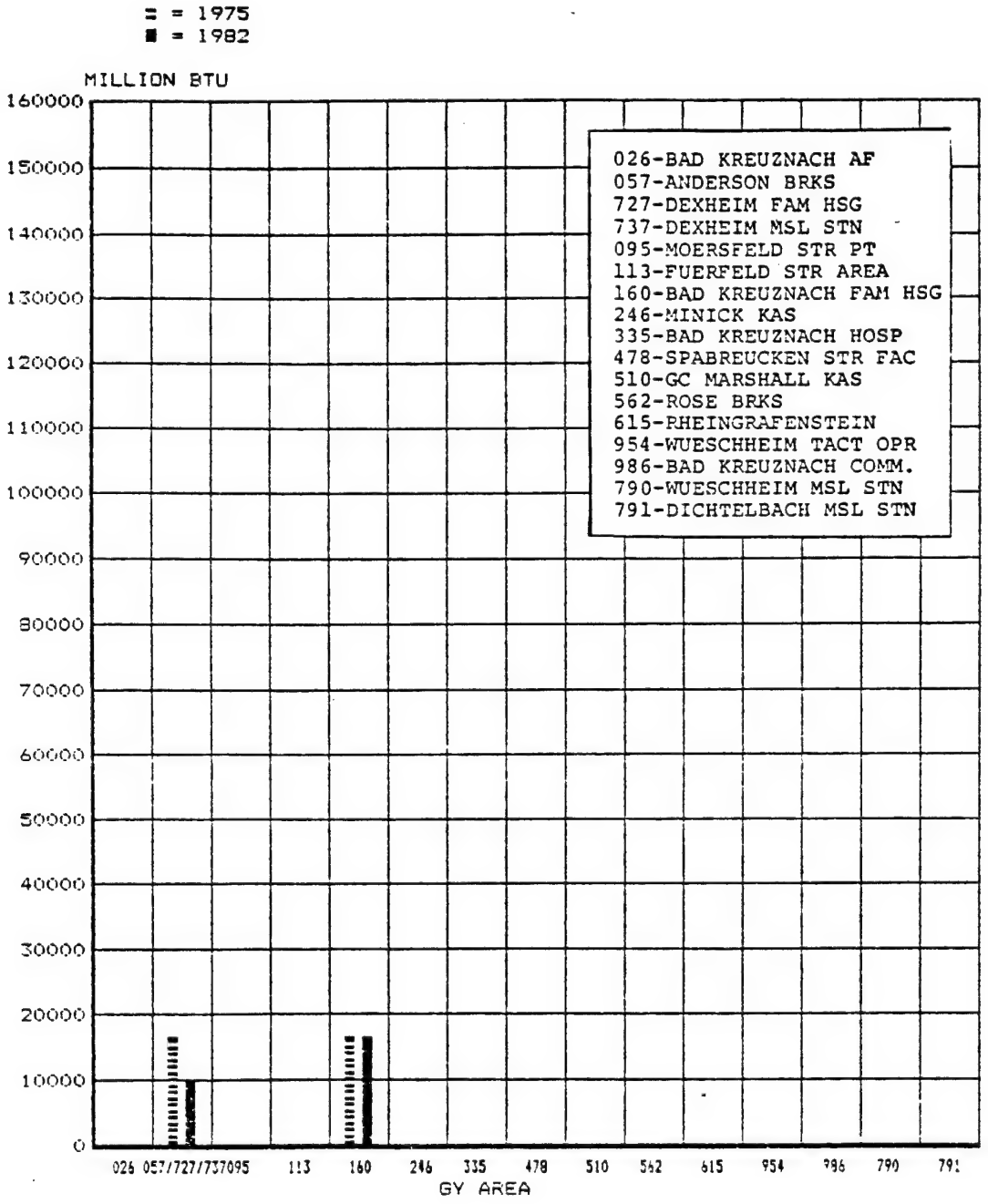


FIGURE A-4

FUEL OIL/GAS CONSUMPTION BY GY AREA
(FY 75 vs FY 82)

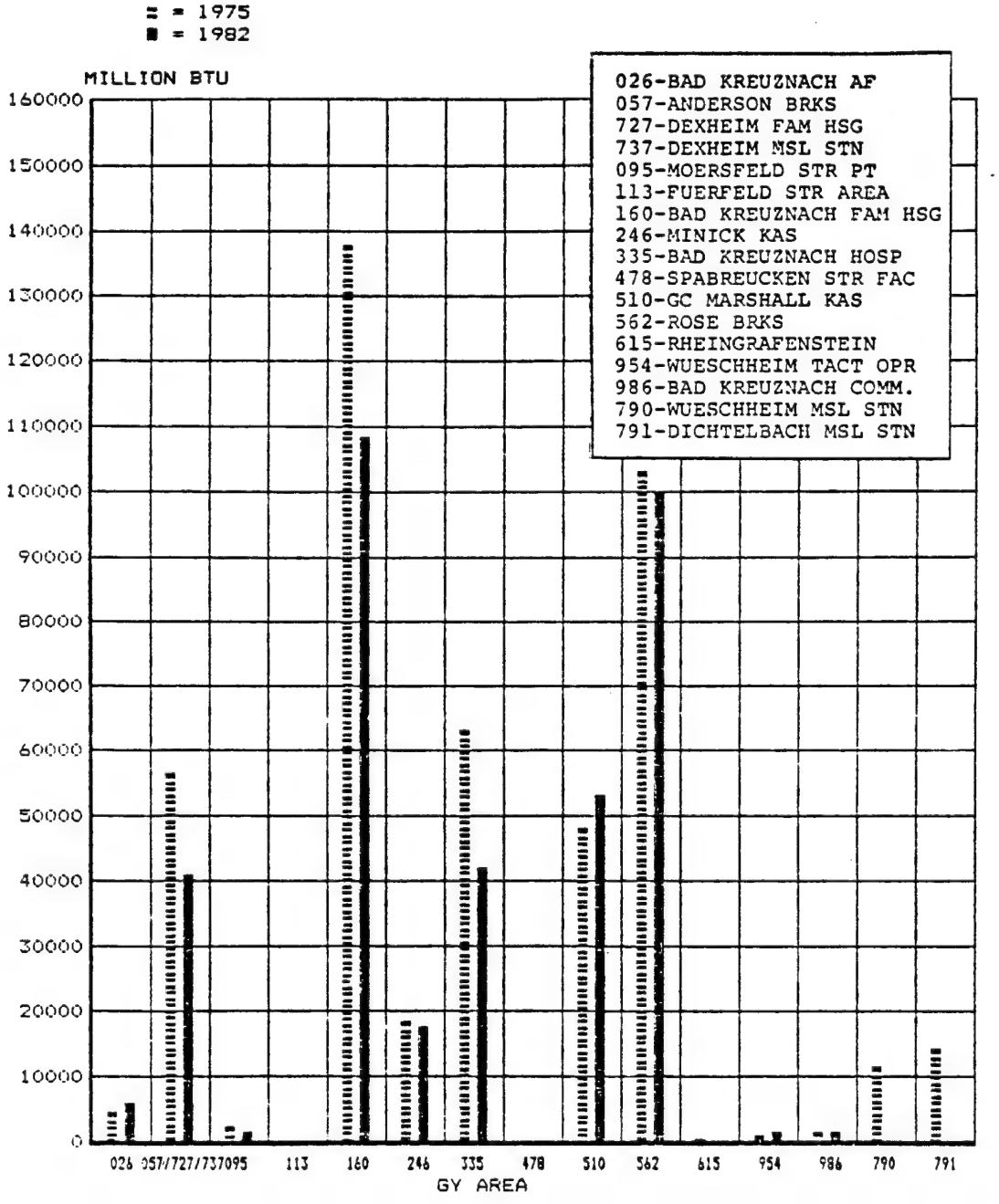


FIGURE A-5

ELECTRICITY CONSUMPTION BY GY AREA
(FY 75 vs FY 82)

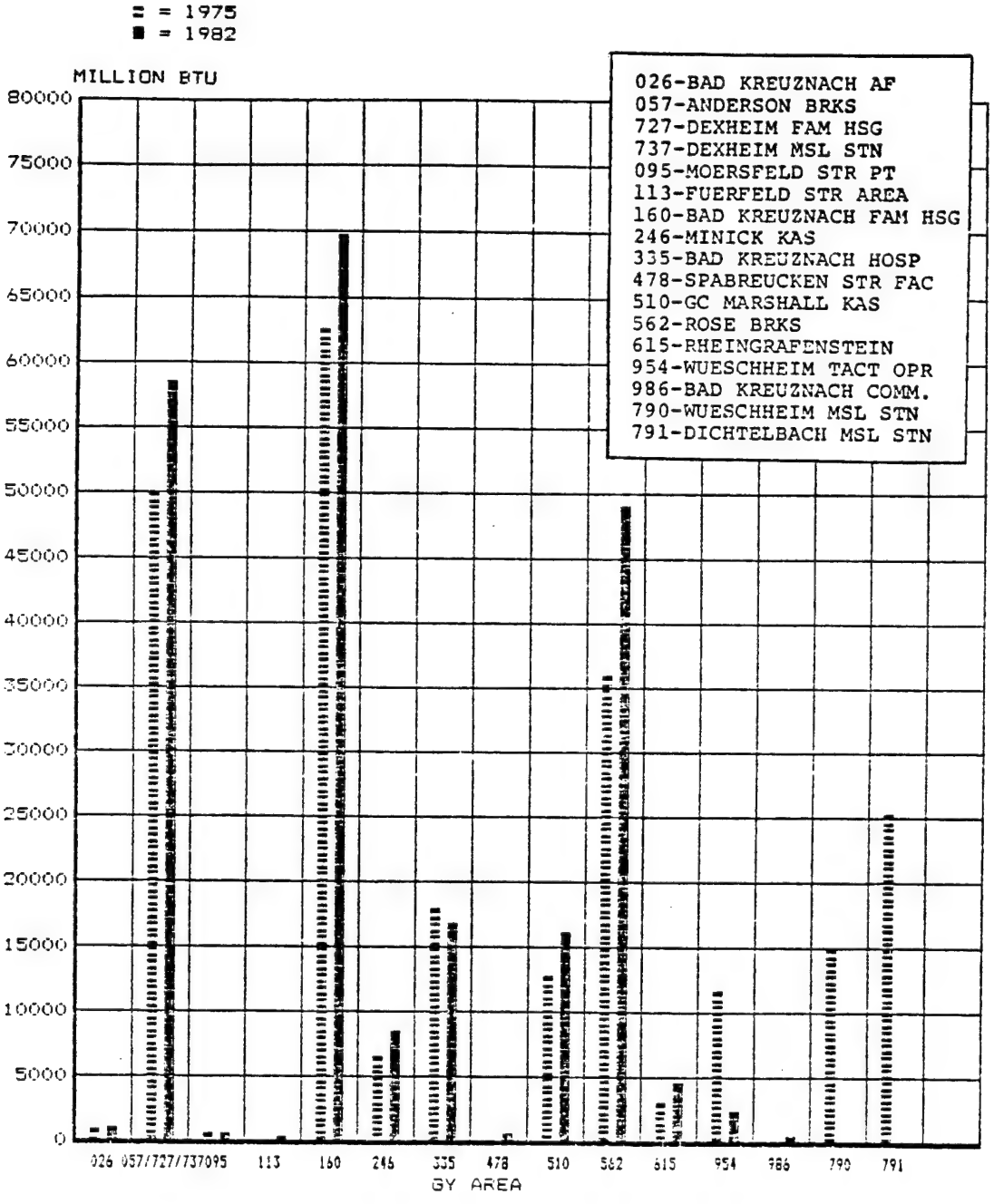


FIGURE A-6

CALCULATED ENERGY REQUIREMENT BY FACILITY TYPE
(Fossil Fuel and Electricity)

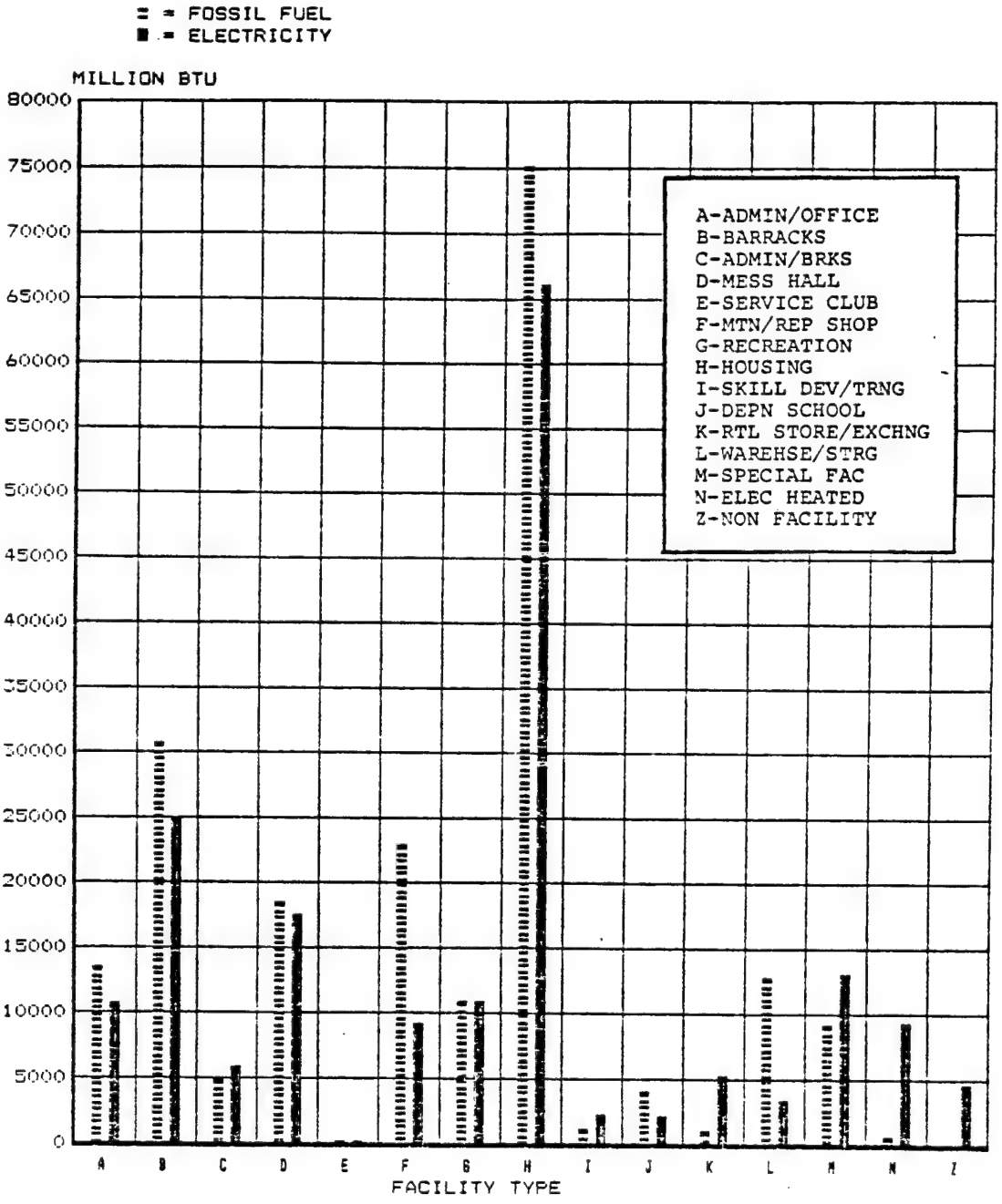


FIGURE A-7

CALCULATED ENERGY REQUIREMENT/SF BY FACILITY TYPE
(Total Energy)

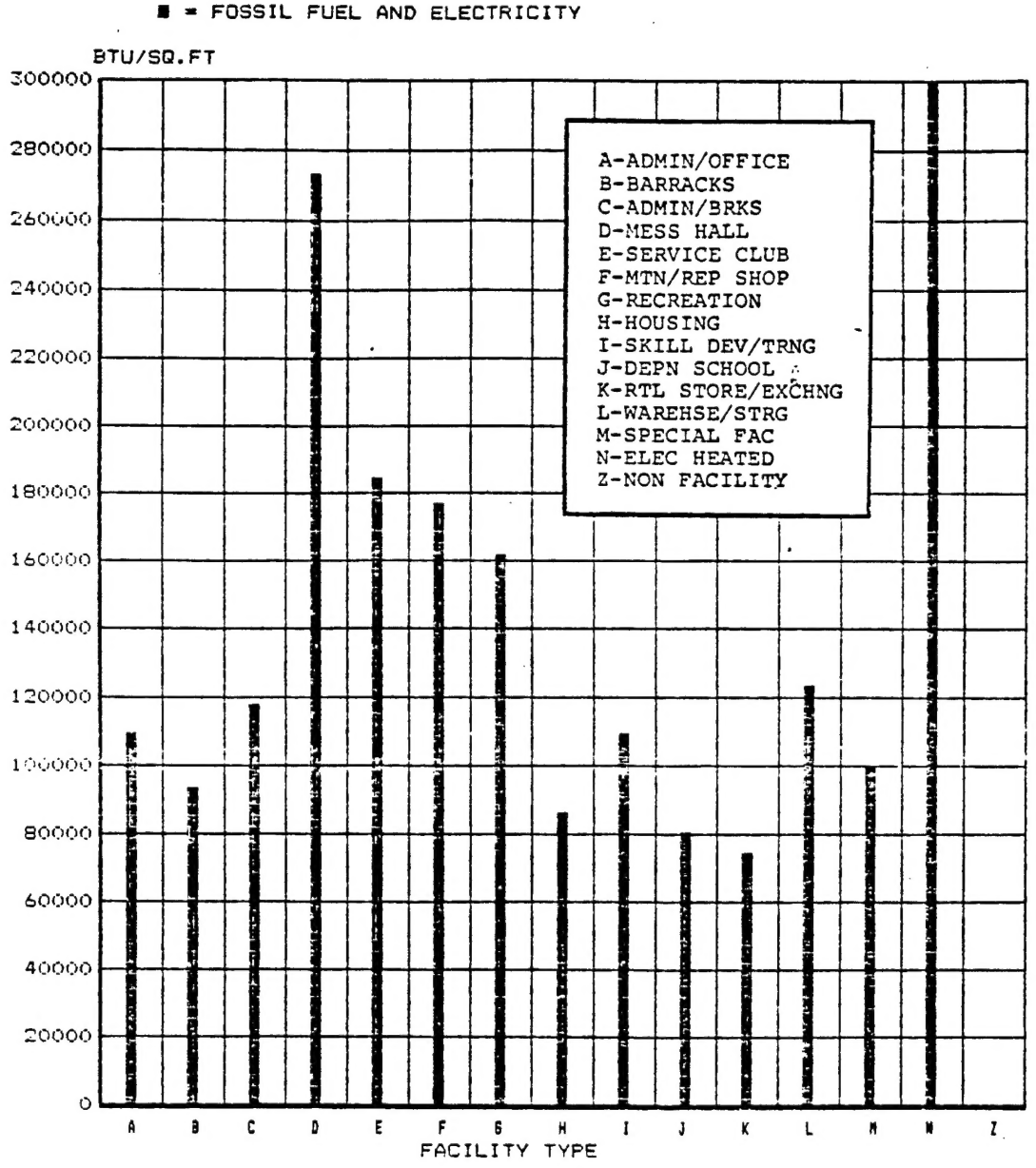


FIGURE A-8

CALCULATED ENERGY REQUIREMENT BY FACILITY TYPE
(Percent Area vs Percent Total Energy)

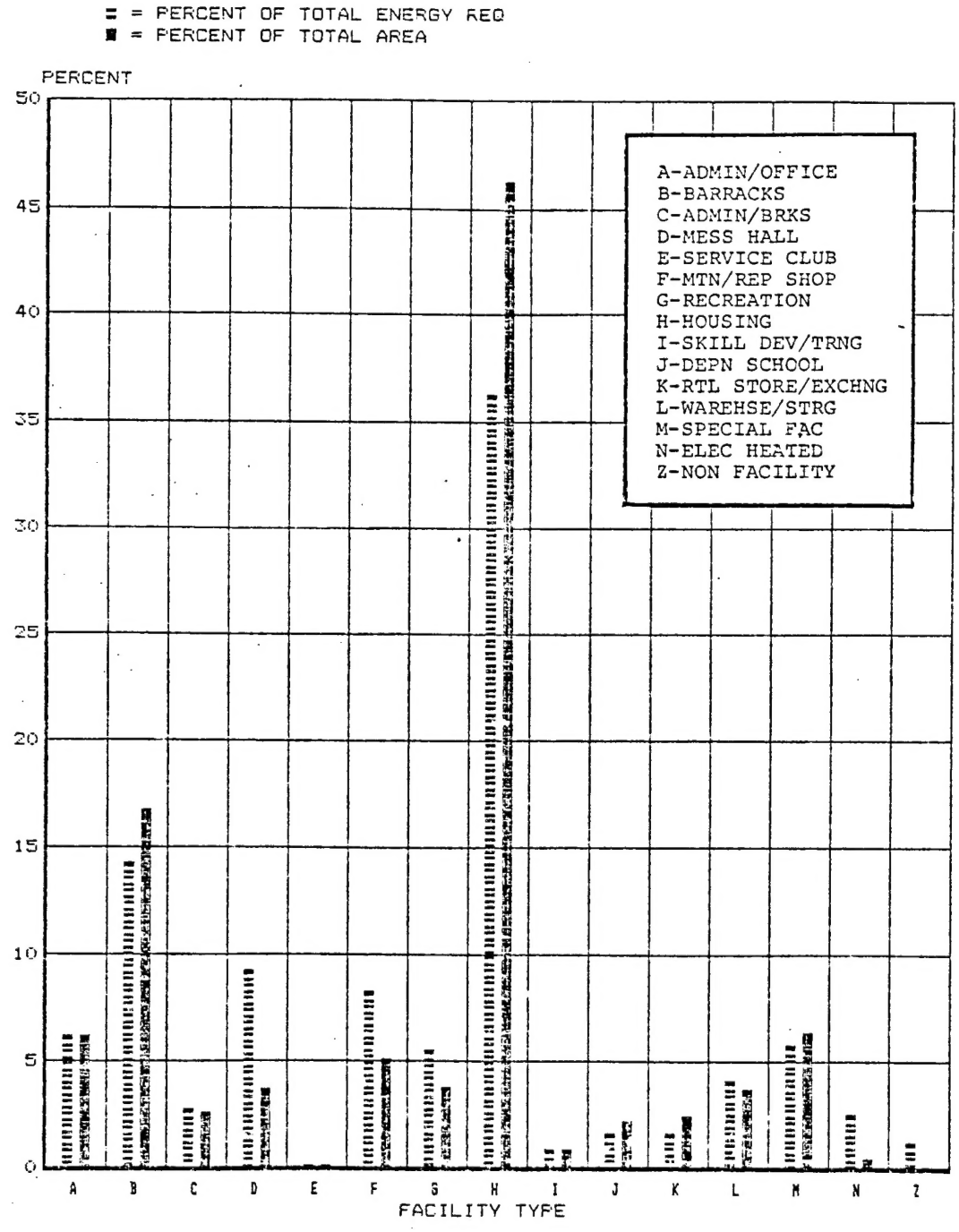


FIGURE A-9

ENERGY CONSUMPTION COMPARISON BY SOURCE
(FY 75 vs FY 85 W/ECOs)

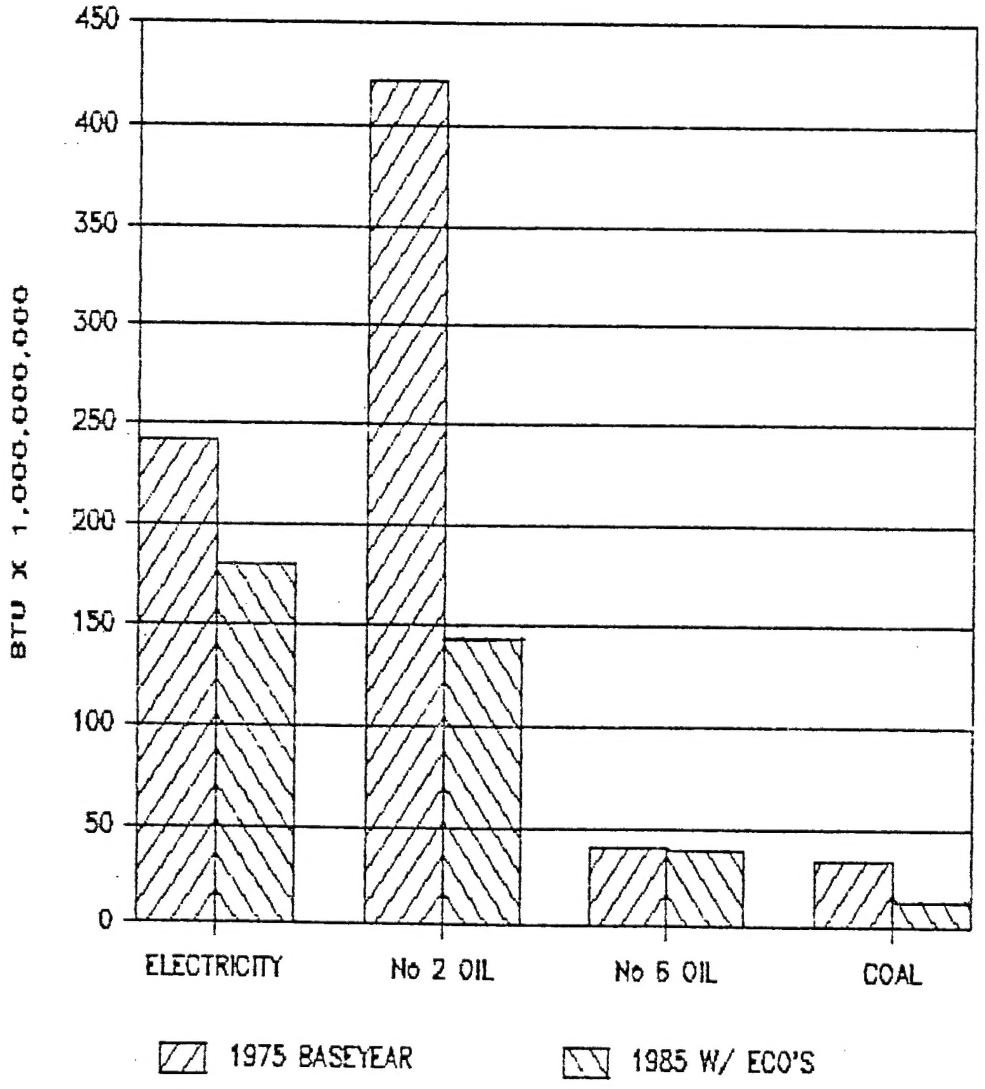


FIGURE A-10

ENERGY COST COMPARISON BY SOURCE
(FY 75 vs FY 85 W/ECOs)